**WTCI-683-P**

**Cheri Sawyer**

**From:** Shyam Sunder [sunder@nist.gov]
**Sent:** Wednesday, September 21, 2005 9:15 AM
**To:** jason.averill@nist.gov; wgrosshandler@nist.gov; rgann@nist.gov
**Cc:** rbukowski@nist.gov; cauffman@nist.gov; cheri.sawyer@nist.gov
**Subject:** Fwd: WTC- No. of occupants in WTC Towers and Cost for Fire Alarm System Upgrade.
**Importance:** High

Jason, Bill, and Dick,

Please use this information to make appropriate changes to your reports. Dick Gann will need to make similar modifications to the towers report. Thanks.

Shyam

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X-Sieve: CMU Sieve 2.2
Date: Wed, 21 Sep 2005 08:56:07 -0400
X-MS-Has-Attach: yes
X-MS-TNEF-Correlator:
Thread-Topic: WTC- No. of occupants in WTC Towers and Cost for Fire Alarm System Upgrade.
Thread-Index: AcW+HEur00RDdMQES5CDb3QfGwfwXgABMY0gACHuJ9A=
From: "Bhol, Saroj" <sbhol@panynj.gov>
To: "Shyam Sunder \(E-mail\)" <sunder@nist.gov>
Cc: "Begley, James" <jbegley@panynj.gov>, "Fadavi, Ali" <afadavi@panynj.gov>, "Lin, C. John" <jlin@panynj.gov>, "Lombardi, Frank" <flombard@panynj.gov>, "Zipf, Peter" <pzipf@panynj.gov>
X-Spam: [F=0.0100000000; S=0.010(2005092001)]
X-MAIL-FROM: <sbhol@panynj.gov>
X-SOURCE-IP: [209.135.48.25]
X-MailScanner:
X-MailScanner-From: sbhol@panynj.gov
Subject: WTC- No. of occupants in WTC Towers and Cost for Fire Alarm System Upgrade.

Shyam,

Here's the information regarding the number of occupants and the cost for fire alarm system upgrade that you had asked me at the conference:

- Number of Occupants: Estimated number of people that worked in each tower, based on an average of 150 work stations on an open floor, could be between 15,000 to 16,000. The maximum number of occupants in each tower, including visitors and tourists most likely would never have exceeded 20,000. Turnstile counts would give a higher number since the people who worked in the towers would go out and come back in through the turnstiles for various reasons. Estimated numbers( 20,000 and 25,000) in the last paragraph of Section 7.1.4 in NCSTAR 1 appears to be high.
- Cost of Fire alarm System Upgrade: Total cost of the upgrade completed before 9/11/01 was $ 69,050,000 (not including financial expense & PA overheads). Please see the attached pages,

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Section 11.2 for the three phases and Section 11.5 (Summary and Cost Table) for cost breakdown. I believe NIST has the full report.

Please let me know if you need any further information.

Thanks

Saroj

<<*WTC.doc*>> Saroj Bhol, P.E. Manager, Design Standards Unit

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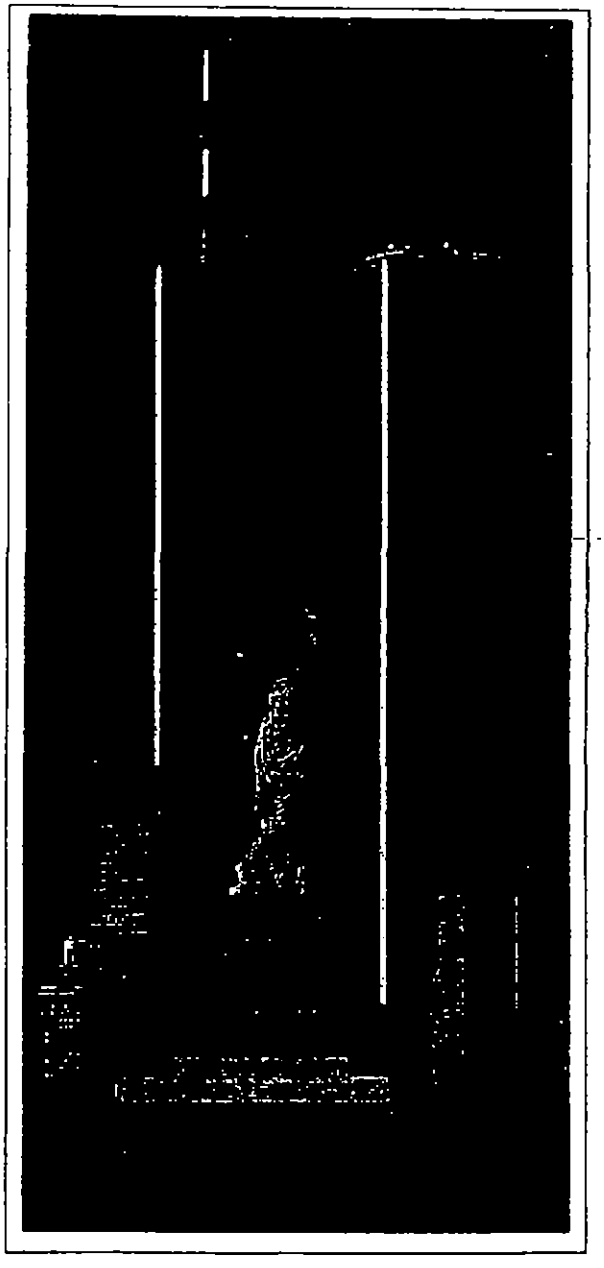
whole report is } 673-P



WORLD TRADE CENTER

# GENERAL DESCRIPTION OF ALL BUILDING SYSTEMS AND THE CAPITAL PROGRAM

**FOR**
**1, 2, 4 & 5 WORLD TRADE CENTER INCLUDING THE ENTIRE PLAZA CONCOURSE AND THE SUBGRADE**

Prepared for:

**World Trade Center Properties LLC**
**Silverstein Properties, Inc.**
**Silverstein WTC Mgmt. Co. LLC**
**1 World Trade Center LLC**
**2 World Trade Center LLC**
**4 World Trade Center LLC**
**5 World Trade Center LLC**
**Westfield WTC LLC**
**Westfield Corporation, Inc.**
**Westfield America, Inc.**

Prepared by:

PACO Group, Inc.
Robert Harvey, PE
Michael Poliacof, PE
William Lavin

**August 1, 2002**

- Prisoner Holding Cell Facilities: Prisoner/arrest processing area, two holding cells, CCTV surveillance, etc.
- Reserve Room/Administration: Multi-purpose office waiting/mustering/eating area, management and supervisory area, administrative support, equipment storage, etc.
- Detective Area: Interview rooms, line-up room, detective work area, holding area, etc.
- Police Locker Rooms: Male/female supervisors' and separate male/female officers' locker rooms, including shower and toilet facilities.

Dates: Start 1998 – Substantial Completion 2000

**Cost of Police Command Center**

| *PA JOB #* | *SYSTEM/ELEMENTS* | *ACTUAL $ SPENT THRU INCEPTION* | *COMMENTS* |
|---|---|---|---|
| | **Police Command Center** | **$7,000,000** | **Estimated (because transferred to completed construction)** |
| ***TOTAL CONSTRUCTION COST*** | **Police Command Center** | ***$7,000,000**** | ***** Not Including Financial Expense & PA Overheads** |

***Note: Above table includes approximate budgeted (in project proposals) or estimated costs of program components and is used in comparison with the Port Authority summary general ledger reports to estimate the approximate completion of the program as of 9/11/01.***

## 11. Fire Alarm System

### 11.1. Existing System

The existing fire alarm (FA) system, as manufactured by American Multiplex System, covered the following areas:

a. One World Trade Center (Tower One)
b. Two World Trade Center (Tower Two).
c. Four World Trade Center.
d. Five World Trade Center.
e. Concourse Level.
f. Subgrade Levels.

The existing centralized FA system consisted of Remote Multiplexing Terminals (RMTs), to which the existing FA devices (smoke detectors, manual pull stations, tamper and flow switches, etc.), tenant panels, and security sensors were connected. The RMTs were linked to the old Operation Control Center (OCC) main and back-up computers.

Each of the mechanical rooms in 1 and 2 WTC were connected to a Pyrotronics XL3 system and linked to a Pyrotronics CXL panel in the OCC.

An Executone System located in the OCC supplied the public address communication system in the corridor ceiling mounted speakers, the HVAC duct mounted speakers, the stairway speakers, and the OCC. In addition, Break Glass Stations, located on each floor, were wired back to the Executone System and were used to notify the Fire Department of an alarm.

### 11.2. Fire Alarm Phases

In order to maintain the existing FA system while installing the new system, a three-phase plan was developed as follows:

Phase I – Installation of the new Pyrotronics MXLV backbone riser equipment, which consisted of remote transponder panels (MXLRV) and amplifier cabinets placed (typically) on every third floor in each of the Towers. A Terminal Strip Cabinet (TSC), which consisted of terminal blocks, was placed on every floor and wired back to the transponder, so that any existing or new devices such as smoke detectors, speakers, etc., would have been connected to the new system under Phase III. An Interface Cabinet (IC), which consisted of interface modules, was placed in the corridor electrical closet next to the existing RMT in order to interface with the existing FA system.

Phase II – The connection between the new FA system and the existing system was accomplished under this phase and was performed on a point-by-point basis. During this phase, both the new Pyrotronics and the existing American Multiplex System were operating concurrently. Once the transfer was completed, the existing system was no longer a part of the fire alarm system, and all functions were carried out by the Pyrotronics MXLV system.

Phase III – This phase was to bring all occupied areas to full conformance with the New York City Building Code – Class "E" system, the ADA, the NFPA, and all other applicable codes. New addressable area and duct smoke detectors, pull stations, strobes, speakers, and warden's phones were to be installed and wired to the TSCs, which were installed under Phase I.

### 11.3. New Fire Alarm System Capabilities

The new decentralized system included six independent FA systems as follows: 1 WTC, 2 WTC, 4 WTC, 5 WTC, the concourse level, and the subgrade level each had a system. Each of the systems was linked to a

Network Command Center (NCC) located in the Fire Command Station (FCS) in the lobby of each of the four buildings. In addition, remote NCCs were installed in buildings 4 and 5 to backup each other, the sub grade and concourse main and remote NCCs in buildings 1 and 2 respectively, and the 2 WTC remote NCC in 1 WTC. Furthermore, back-up NCCs for all six systems were installed in the new OCC, so that, in the event of an emergency, the entire WTC FA system could be monitored and controlled from a safe remote location.

Each of the NCCs was connected to a dedicated logging printer that provides a sequential log of events and operator actions. Additionally, color graphics software was installed in the new FA system so that, in the future, when the design of the FA system was completed and floor plans (for the entire WTC complex) indicating the location of all FA devices were available, a color laser printer could be used to print graphic screen images, which, in the event of an alarm, could show the exact location of the active device so that the response team could locate the problem area easily and act accordingly.

To enhance the integrity and reliability of the new FA system, a Style 7 Network wiring scheme was chosen, which included two additional independent network risers installed in two additional rigid conduits (totaling three conduits) at different locations (the fire alarm closet and two separate stairways). This scheme of wiring accommodated any type of circuit malfunction (short or open) in any section of the network risers. Additionally, the network risers utilized #14 AWG Teflon cables (twisted pair, 600V, 200°C).

Furthermore, the Pyrotronics NCC Global/Local (NCC-G/L) Fiber Optic Token Ring LAN, which operated independently of both the MXLV network and the RS-485 style 7 network, allowed each NCC on the LAN to monitor/control any combination of the six FA systems. The fiber optic cable was installed in rigid conduits and was to be run in a closed ring topology around the entire WTC complex. The cable had self-healing characteristics in the event of damage of the fiber optic assembly.

### 11.4. Phase III Implementation

The following systems/devices were used to bring all occupied areas up to full conformance with all applicable codes

- Wall-mounted strobe units were installed in all corridors, bathrooms, common areas, and all occupied tenant spaces.
- Ceiling-mounted speakers were installed in all corridors, bathrooms, common areas, and all occupied tenant spaces.
- Addressable area smoke detectors were installed in all base-building electrical and telephone closets, mechanical rooms, and elevator machine rooms, and in elevator lobbies for elevator recall.

Additionally, duct-mounted smoke detectors and area detectors were installed in front of the return/supply air grills for fan shut-down.

- Pull stations were installed next to each stairway and in the main exits in the main lobbies.
- All existing sprinklers' tamper and flow switches were connected via interface modules.
- All tenant proprietary fire alarm panels were connected to the FA system via interface modules, so that they could transmit alarm or trouble.
- A floor warden station was installed on every floor to establish two-way telephone communication between each floor and the Fire Command Station. Also, a stairway standpipe fireline telephone jack was installed for Fire Department use.

### 11.5. Summary

Phases I and II of the fire alarm system plan was completed in all areas. The status of Phase III contracts and the balance of the construction costs were as follows:

- 1 WTC – Phase III was about 85 percent completed and there was a balance of $2,400,000 for completion.
- 2 WTC – Phase III was about 80 percent completed and there was a balance of $2,800,000 for completion.
- 4 & 5 WTC - Phase III was about 60 percent completed and there was a balance of $2,400,000 for completion.
- Concourse Level - Phase III was 100 percent completed.
- Subgrade Levels - Phase III was 0 percent completed and there was a balance of $10,600,000 for completion.
- Subgrade Levels Backbone Modifications – 0 percent completed and there was a balance of $2,800,000 for completion.
- XL3 conversion to Pyrotronics MXLV system in all mechanical rooms – about 40 percent completed and there was a balance of $1,400,000 for completion.
- Fiber Optic Loop – 0 percent completed and there was a balance of $3,000,000 for completion.

It is estimated that the life expectancy of the system would have been 25 years.

**Cost of Fire Alarm System**

| *PA JOB #* | *SYSTEM/ELEMENTS* | *ACTUAL $ SPENT THRU INCEPTION* | *COMMENTS* |
|---|---|---|---|
| CW02-033 | Fire Alarm Systems Phase I & II | $25,647,000 | |
| CW02-034 | Fire Alarm Systems Phase III | $43,220,000 | |
| CW02-038 | Fire Alarm Systems Phase III - Tenant | $183,000 | |
| *Total Construction Cost* | Fire Alarm Systems | *$69,050,000 | *Not including Financial Expense & PA Overheads |

***Note: Above table includes approximate budgeted (in project proposals) or estimated costs of Capital Program components and is used for comparison with the Port Authority summary general ledger reports to estimate the approximate completion of the program as of 9/11/01.***

## 12. Miscellaneous Life Safety Improvements and Sprinklerization Program

### 12.1. Description of the Program

The initial base building provided for fire standpipe (FSP) protection in the Towers and plaza buildings and no sprinkler system installation (except in the subgrade levels). In response to the enactment of Local Law 5 and other NYC Building Code Local Law enactments related to the fire protection of high-rise office towers built after 1973, the Port Authority voluntarily retrofitted the WTC complex to comply with the new NYC Building Code requirements supplemented by PA-imposed life-safety requirements unique to the WTC. These requirements provided tenants the option of achieving fire protection compliance by a compartmentalization or a sprinklerization option. The scope of miscellaneous life safety and sprinkler system upgrades/improvements, other than certain fire alarm, concourse circulation and blast recovery improvements discussed elsewhere, is outlined below.

### 12.2. Scope of Fire Life Safety Improvements

Architectural Modifications on All Floors:

- Upgraded core wall construction to provide for a 2-hour rated fire separation from one side of a tower floor to the opposite side. (Where core walls were already 2-hour rated, such as in elevator shafts, there were upgrades where not previously required.)

- Installed a double acting set of rated HM fire doors in the core corridors where the above 2-hour rated fire separation crossed the corridor. This enabled one half of a typical tower floor to serve as a horizontal fire refuge for the other. Doors included special magnetic hold-open

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